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Quarterly Report

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Prepared for: United States Department of Transportation
Pipeline and Hazardous Materials Safety Administration
Office of Pipeline Safety

Project Title: "Understanding Magnetic Flux Leakage (MFL) Signals from Mechanical Damage in Pipelines"

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Background

In an effort to improve safety and minimize environmental impact, there is increasing emphasis of pipeline operators and inspection vendors to locate and accurately assess mechanical damage. Caliper tools can be used to predict sizes of simple dents, but cannot detect the presence of external gouging, corrosion pitting, stresses or cracking associated with those dents. MFL tools have the potential to characterize dents and gouges, but as yet the MFL signals from these features are not sufficiently understood to be used for reliable mechanical damage detection and characterization. In order to reliably use MFL tools for mechanical damage assessment, we need to understand the origin of the MFL signal from dents and gouges. This project addresses that need.

Technical Status

Work in this quarter was focused on Task 9 "Characterizing Magnetic Response of Gouged Pipeline Material" and Task 13 "Collaboration with DOT Project DTPH56-06-T-000016".

New test gouges of different sizes and severity were produced on polished steel plate samples of dimensions 18" × 18" × 0.2" using a grinding wheel and a backhoe tool. For MBN measurements, the gouges were produced in the rolling (axial) as well as transverse (circumferential) direction, and both linear and angular scans were performed at a number of locations inside as well as outside the gouged region. The MFL measurements were also performed on all the samples with the magnetic field applied along the axial and circumferential directions. The results of MBN as well as MFL measurements were analyzed to obtain information about the strains present in the magnetically correlated regions, which was used to obtain the magnetic response parameters of the damaged sections (Task 9.5). Magnetic finite element models were produced for a few representative gouges to study the effect of gouge's complex geometry as well as strains on the axial, radial and circumferential MFL signal components (Task 9.6).

The work on magnetic finite element modeling of MD1-1 dents was extended to model circular dents of the type MDR07 (notation from the MD1-1 project) based on the stress information obtained from the structural finite element modeling. The stress information was obtained for the pipeline under 'no pressure' condition and in the presence of an internal pressure of 235 MPa. Modeled data for all the three MFL components (axial, radial and circumferential) were produced. The modeled axial results were compared with the corresponding decoupled pull test results reported by MD1-1 team in one of their papers presented at the International Pipeline Conference 2008. There was, in general, a good agreement. We also had opportunity to have informal discussions with the MD1-1 team members during the recent IPC 2008 Conference in Calgary.

Plans for Future Activity

The following work is planned for the next quarter:

- MFL measurements will be performed on gouged pipeline sections available at the Gaz de France. These gouges will be modeled using the magnetic FE modeling and the results will be compared with the experimental data. (Tasks 10.1 and 10.2).
- The results of Tasks 9 and 10 will be added to the database (Task 8.3).